NEWS SCIENCE NEWS

DR NIKOLA TESLA ON DETECTING AND COMBATTING SUBMARINES

In 1917, H. Winfield Secor, associate editor of *The Electrical Experimenter* magazine, was fortunate enough to obtain an exclusive interview with the world-famous electrical inventor Dr Nikola Tesla. It was published in the August issue of the magazine under the title "Tesla's Views on Electricity and the War". The interview is now available, courtesy of Larry Brian Radka of Einhorn Press, at http://einhornpress.com /inventor.aspx

— Editor

Nikola Tesla, one of the greatest of living electrical engineers and recipient of the seventh "Edison" medal, has evolved several unique and far-reaching ideas which if developed and practically applied should help to partially, if not totally, solve the much discussed submarine menace and to provide a means whereby the enemy's powder and shell magazines may be exploded at a distance of several miles.

There have been numerous stories bruited about by more or less irresponsible self-styled experts that certain American inventors, including Dr Tesla, had invented among other things an electric ray to destroy or detect a submarine under water at a considerable distance. [Dr] Tesla very courteously granted the writer an interview and some of his ideas on electricity's possible role in helping to end the great world-war are herein given:

"The all-absorbing topic of daily conversation at the present time is of course the 'U-boat'." Therefore, I made that subject my opening shot.

"Well," said Dr Tesla, "I have several distinct ideas regarding the subjugation of the submarine. But lest we forget, let us not underestimate the efficiency of the means available for carrying on submarine warfare. We may use microphones to detect the submarine, but on the other hand the submarine commander may employ microphones to locate a ship and even torpedo it by the range thus found, without [e]ver showing his periscope above water.

"Many years ago, while serving in the capacity of chief electrician for an electric plant situated on the river Seine in France, I had occasion to require for certain testing purposes an extremely sensitive galvanometer. In those days the quartz fiber was an unknown quantity—and I, by becoming specially adept, managed to produce an extremely fine cocoon fiber for the galvanometer suspension. Further, the galvanometer proved very sensitive for the location in which it was to be used, so a special cement base was sunk in the ground and, by using a lead sub-base suspended on springs, all mechanical shock and vibration effects were finally gotten rid of.

"As a matter of actual personal experience," said Dr Tesla, "it became a fact that the small iron-hull steam mail-packets [ships] plying up and down the river Seine at a distance of three miles would distinctly affect the galvanometer!"

"How could this be applied to the submarine problem?" I asked.

"Well, for one thing," the scientist replied, "I believe the magnetic method of locating or indicating the presence of an iron or steel mass might prove very practical in locating a hidden submarine. And it is of course of paramount importance that we do find a means of accurately locating the sub-sea fighters when they are submerged, so that we can, with this information, be ready to close in on them when they attempt to come to the surface. Especially is this important when several vessels are traveling in fleet formation; the location and presence of the enemy submarine can be radiographed to the other vessels by the one doing the magnetic surveying and, by means of nets in some cases, or gun-fire and the use of hydro-aeroplanes sent aloft from the ships, the enemy under water stands a mighty good chance of being either 'bombed', shelled or netted.

"However, a means would soon be found of nullifying this magnetic detector of the submerged undersea war-craft. They might make the 'U-boat' hulls of some non-magnetic metal, such as copper, brass, or aluminum. It is a good rule to always keep in mind that for practically every good invention of such a kind as this, there has always been invented an opposite, and equally efficient, counteracting invention."

"How about this new electric ray method of locating submarines?" I ventured to ask.

"Yes, yes, I am coming to that," the master electrician parried. "Now suppose

that we erect on a vessel a large rectangular helice or inductance coil of insulated wire. Actual experiments in my laboratory at Houston Street (New York City) have proven that the presence of a local iron mass such as the ship's hull would not interfere with the action of this device.

"To this coil of wire, measuring perhaps 400 feet in length by 70 feet in width, the breadth of the ship, we connect a source of extremely high frequency and very powerful oscillating current. By this means there are radiated powerful oscillating electro-static currents, which as I have found by actual experiment in my Colorado tests some years ago will first affect a metallic body (such as a submarine hull, even though made of brass or any other metal) and in turn cause that mass to react inductively on the exciting coil on the ship. To locate an iron mass, it is not necessary to excite the coil with a high frequency current; the critical balance of the coil will be affected simply by the presence of the magnetic body.

"To be able to accurately determine the direction and range of the enemy submarine, four exciting inductances should be used.* With a single inductance, however, it would be possible to determine the location of a submarine by running the ship first in one direction and then in another, and noting whether the reactance effect caused by the presence of the submarine hull increased or decreased. The radiating inductance must be very sharply attuned to the measuring apparatus installed on the ship, when no trouble will be found in detecting the presence of such a large metallic mass as a submarine, even at a distance of five to six miles; of this I feel confident from my past experiments in the realm of ultra-high frequency currents and potentials."

"I could walk on the sand (ordinarily considered a very good insulator) several hundred feet from my large high-frequency oscillator, and sparks jumped from my shoes!"

Back to the Colorado Tests

"What particular experiments do you have in mind, Dr Tesla?" I asked.

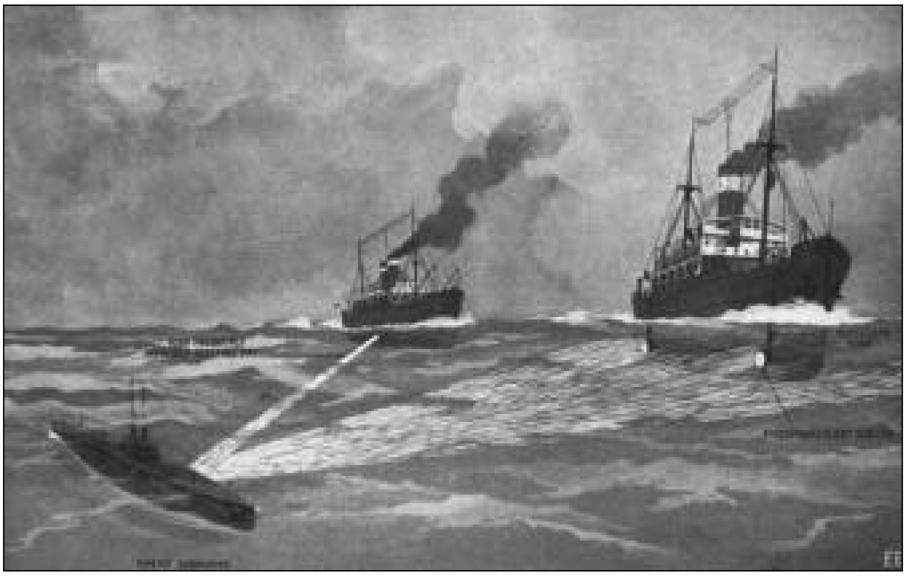
"The Colorado tests of 1898–1900. Wonderful were the results obtained, both those anticipated as well as those unexpected. As an example of what has been done with several hundred kilowatts of high frequency energy liberated, it was found that the dynamos in a power house six miles away were repeatedly burned out, due to the powerful high-frequency currents set up in them and which caused heavy sparks to jump through the windings and destroy the insulation!

"The lightning arresters in the power house showed a stream of blue-white sparks passing between the metal plates to the earth connection. I could walk on the sand (ordinarily considered a very good insulator) several hundred feet from my large high-frequency oscillator, and sparks jumped from my shoes! At such distances all incandescent lamps glowed by wireless power,** and banks of lamp, connected to a few turns of wire arranged in a coil on the ground, were lighted to full brilliancy. The effect on metallic objects at considerable distances was really remarkable."

I asked him about the "Ulivi ray", which was accorded considerable newspaper publicity some time ago.

"The 'Ulivi ray' really was transplanted from this country to Italy," asserted Dr Tesla. "It was simply an adaptation of my ultra-powerful high-frequency phenomena as carried out in Colorado and cited previously. With a powerful oscillator developing thousands of horsepower, it would become readily possible to detonate powder and munition magazines by means of the high frequency currents induced in every bit of metal even when located five to six miles away and more. Even a powder can would have a potential of 6,000 to 7,000 volts induced in it at that distance.

"At the time of those tests, I succeeded in producing the most powerful X-rays ever seen. I could stand at a distance of 100 feet from the X-ray apparatus and see the bones of the hand clearly with the aid of a fluoroscope screen; and I could have easily seen them at a distance several times this by utilizing suitable power. In fact, I could not then procure X-ray generators to handle even a small fraction of the power I had available. But I now have apparatus designed whereby this tremendous energy of hundreds of kilowatts can be successfully transformed into X-rays."



Nikola Tesla, the famous electric inventor, has proposed three different electrical schemes for locating submerged submarines. The reflected ray method is illustrated above. The high-frequency invisible electric ray, when reflected by a submarine hull, causes phosphorescent screens on another or even the same ship to glow, giving warning that the U-boats are near. (Source: *The Electrical Experimenter*, August 1917)

Submarine Warfare

"Could these ultra-powerful and unusually penetrating X-rays be used to locate or destroy a submarine?" I interjected.

"Now we are coming to the method of locating such hidden metal masses as submarines by an electric ray," replied the electrical wizard. "That is the thing which seems to hold great promises. If we can shoot out a concentrated ray comprising a stream of minute electric charges vibrating electrically at tremendous frequency, say millions of cycles per second, and then intercept the ray after it has been reflected by a submarine hull, for example, and cause this intercepted ray to illuminate a fluorescent screen (similar to the X-ray method) on the same or another ship, then our problem of locating the hidden submarine will have been solved.

"This electric ray would necessarily have to have an oscillation wave length extremely short, and here is where the great problem presents itself, i.e., to be able to develop a sufficiently short wavelength and a large amount of power, say several thousand or even several hundred thousand horsepower. I have produced oscillators having a wavelength of but a few millimeters.

"Suppose, for example, that a vessel is fitted with such an electric ray projector. The average ship has available from, say, 10,000 to 15,000 H.P. The exploring ray could be flashed out intermittently, and thus it would be possible to hurl forth a very formidable beam of pulsating electric energy, involving a discharge of hundreds of thousands of horsepower. The electric energy would be taken from the ship's plant for a fraction of a minute, only being absorbed at a tremendous rate by suitable condensers and other apparatus from which it could be liberated at any rate desired.

"Imagine that the ray has been shot out and that in sweeping through the water it encounters the hull of a submarine. What happens? Just this: the ray would be reflected, and by an appropriate device we would intercept and translate this reflected ray, as for instance by allowing the ray to impinge on a phosphorescent screen, acting in a similar way to the X-ray screen. The ray would be invisible to the unaided eye. The reflected ray could be, firstly, intercepted by the one or more ships in the fleet, or, secondly, it would be possible for the ship originating the ray to intercept the refracted portion by sending out the ray intermittently and also by taking advantage of what is known as the after-glow effect, which means that the ray would affect the registering screen an appreciable time after its origination. This would be necessary to allow the ship to move forward sufficiently to get within range of the reflected ray from the submarine, as the reflection would not be in the same direction as the originating ray.

"To make this clearer, consider that a concentrated ray from a searchlight is thrown on a balloon at night. When the spot of light strikes the balloon, the latter at once becomes visible from many different angles. The same effect would be created with the electric ray if properly applied. When the ray struck the rough hull of a submarine, it would be reflected, but not in a [con]centrated beam—it would spread out; which is just what we want. Suppose several vessels are steaming along in company; it thus becomes evident that several of them will intercept the reflected ray and accordingly be warned of the presence of the submarine or submarines. The vessels would at once lower their nets, if so equipped, order their gun crews to quarters and double the look-out watch. The important thing to know is that submarines are present. Forewarned is forearmed!

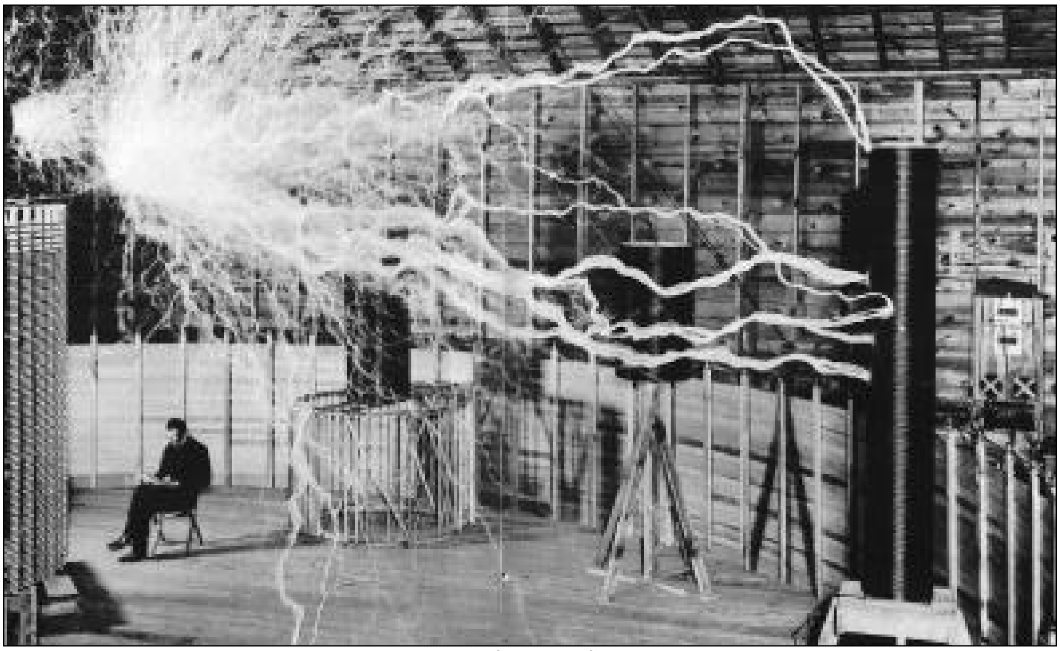
"The Teutons are clever, you know; very, very clever; but we shall beat them," said Dr Tesla confidently. ∞

* Here Tesla is proposing a form of RADAR (an acronym for Radio Detection And Ranging), not fully developed until several years later.

** As an amateur radio operator (KB3ZU), I can attest to the fact that high-frequency radiated power will light up the filaments in electric bulbs with no house-current applied. A few times, I inadvertently left the antenna disconnected while operating my 2,000-watt (PEP) linear amplifier in the 15-metre band, and I watched the filaments in all the turned-off incandescent bulbs in the room light up to about half-normal brilliancy when I spoke over the microphone loudly. This was because of the maximum modulation being reached and my transmitter's output being improperly terminated.

— Larry Brian Radka, Einhorn Press

(Source: Non-facsimile reproduction of "Blinding the Submarine", The Electrical Experimenter, *August 1917, posted at http://einhornpress.com/inventor)*



Tesla at work